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PUTTING SPACE CONTROL ON THE FRONT BURNER IN OPERATIONAL PLANNING

By

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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Unfortunately, space expertise is limited. The burden then falls to those without much space experience. However, many aspects of space control are common to the protection and execution of forces operating in other mediums. Personnel with such experience can apply that expertise to space control with a little practice and knowing how to ask the right questions. A model is presented here to help planners executing space control. The model does not have the answers, it depends on the initiative and expertise of the planners by leading them through the questions they must consider. While not a panacea, it's a step in getting space control planning on the front burner where it must be the next time the United Sates goes to war. The advantages an enemy can gain and the leverage U.S. forces lose is far too great for anything less.

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Abstract of

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The proliferation of space capabilities around the world and the easy access to them, even by countries or organizations without the infrastructure or financial means for their own capability, means that space control in the future must be a top priority in operational planning. The incredible advances in satellite imagery by commercial and foreign entities and subsequent prolific distribution of high quality imagery, especially over the internet to anyone with a credit card, portend complex issues for U.S. planners working space control issues. Non-military as well as creative military means will have to be devised.

Unfortunately, space expertise is limited. The burden then falls to those without much space experience. However, many aspects of space control are common to the protection and execution of forces operating in other mediums. Personnel with such experience can apply that expertise to space control with a little practice and knowing how to ask the right questions. A model is presented here to help planners executing space control. The model does not have the answers, it depends on the initiative and expertise of the planners by leading them through the questions they must consider. While not a panacea, it's a step in getting space control planning on the front burner where it must be the next time the United Sates goes to war. The advantages an enemy can gain and the leverage U.S. forces lose is far too great for anything less.

INTRODUCTION

The United States must win and maintain the capability to control space in order to assure the progress and pre-eminence of the free nations. If liberty and freedom are to remain in the world, the United States and its allies must be in a position to control space.
General Thomas D. White
Air Force Chief of Staff, 1955

The Gulf War has been called the first "Space War" primarily because of the extensive use of space assets as force enhancers. Coalition forces relied on space-based systems for navigation, communications, and surveillance or intelligence ranging from imagery, to weather, to signals intelligence, to early warning of Scud launches. Although there was a great reliance on space then, all the systems were in a support role. No weapons were launched from space and there were no attacks in, towards, or from space. In fact, the coalition essentially had a monopoly on space assets. Iraq had virtually no indigenous capability to exploit space assets. Neither did they attempt attacks to deny coalition use of space assets. How then was the Gulf War a "Space War"? The biggest challenges to the U.S.-led coalition's dominance of space capability came from trying to operationally take advantage of the multinational space capabilities in existence.[1] An illustrative example was the widely publicized case of families in the United States purchasing commercial Global Positioning System (GPS) receivers and shipping them to troops in the desert because DOD didn't have enough. In the Gulf, space capabilities were more widely exploited than ever before, but planning to defend or attack space capabilities simply was not critical. In view of these circumstances, is space control even an issue?

THESIS

In today's and tomorrow's environment space control must not be an afterthought or taken for granted as a unique advantage for the United States. It deserves, even requires the

same level of effort operational planners give to the protection and execution of friendly ground, sea and air forces as well as the disruption or denial of the same to an adversary. Even planners without specific space expertise can effectively contribute to space control planning. Their various backgrounds and experience have direct application in many aspects of space control. By raising their level of awareness about space control challenges, their valuable potential can be tapped. Immediate attention is necessary to ensure the vital space aspect of warfare is adequately addressed. "SLOC" should no longer be limited to meaning "sea lines of communication;" "space lines of communication" are just as and sometimes more important.

To demonstrate the thesis this paper looks at the concept of space control, first by defining it and discussing some inherent characteristics as well as ramifications for today's environment. The author then shows how the situation is significantly different today than it was in the Gulf War. By limiting the focus specifically to the availability of commercial imagery, he highlights how the requirement to consider space control is much greater and continues to grow, yet to achieve it may require innovative methods. To help address the compelling need for space control, he argues planners without space experience can and should be involved and offers a model to help operational planners identify the issues of space control they may face preparing for a conflict.

One caveat applies throughout the paper: all material for this paper is from unclassified sources. Certainly space control has the potential for getting into highly classified areas, however, to facilitate discussion of the basic concepts and considerations in a wider forum, the decision was taken to use only open sources.

SPACE CONTROL DEFINITIONS AND PLANNING CONSIDERATIONS

Space Control Defined

U.S. Space Command's Long Range Plan defines space control as "the ability to assure access to space, freedom of operations within the space medium, and an ability to deny others the use of space, if required."[2] Thus, space control for the United States has two basic or fundamental functions: the first is to ensure the United States can fully exploit its space systems; the second is to deny an enemy that same capability. There are several aspects to these two fundamental tasks. To clarify and establish a base line for the discussion in this paper, some explanation and background are in order.

Specifically, the two fundamental tasks define space control but do not prescribe how to achieve or sustain it. Space systems are comprised of three subsystems: the space portion, the ground portion, and the communication links. Protecting all three is essential to preserving U.S. capability. At the same time, one or more of an adversary's subsystems could be a vulnerability useful in denying his ability to use space assets.

Planning Considerations

From the perspective of the first fundamental, preserving U.S. capability, some aspects, such as providing physical security to ground assets, are no different than protecting other types of vital terrestrial assets. Such methods can include tight physical security, redundant sites, hidden sites, multiple-use sites, and mobile sites. Similarly, protecting communication links is much like protecting other communication capabilities. Physical hardening, encryption, frequency hopping, increasing power or other techniques such as burst transmissions, etc. are all commonly employed. From the planner's perspective, protecting these assets is critical but not particularly unique.

As for protecting actual assets in space, options are somewhat more limited. At this point, defending spaceborne assets against physical attack is very difficult. The cost of spacelift is so high that any type of armor or shielding has been cost prohibitive because of the extra weight it entails. For the same reason, materials used in spacecraft are by design as lightweight as possible without compromising functionality, which makes them very fragile. Sensors that detect and then self-protect a satellite from blinding are also a possibility and even used on some satellites, but again the tradeoff of value for the weight increase is a serious consideration, especially for commercial satellites. Because TV and movies frequently portray spacecraft in powered flight rather than falling or coasting as a body in orbit does, many people are unaware that satellites and spacecraft do not use propulsion to stay in motion once they are in orbit. Rather, they expend fuel to remain stable and to maintain their orbit as natural forces tend to disrupt it. Satellite maneuvering also is not a rapid-reaction, instantaneous event like rolling a fighter aircraft. It's probably more akin to redirecting an aircraft carrier. Both have tremendous momentum, the carrier because of its mass, the spacecraft because of its speed. In addition, because of limited fuel and the fact that a wild, evasive maneuver may severely disrupt a functional orbit, evading an attack in real time is unlikely. Any maneuvering requires preplanning and lead time. Fortunately, at this point, few countries have the advanced capability to target a given spacecraft. Lasers require tremendous amounts of energy and then must target and track a low-earth orbiting vehicle traveling upwards of 15,000 miles an hour. While a geosynchronous satellite may be easier to track for targeting, its altitude of 22,300 miles makes it a very far reach for any earth-based weapon.

Thus, protecting U.S. space capabilities is primarily a terrestrially focused effort, although there are two other specific threats worth mentioning. The first is an information warfare attack. Space systems are extremely reliant on computers and software. Fortunately, systems can be closed to a large degree so that access can be limited. Additionally, secure encryption is very much standard operating procedure which severely diminishes any chance of injecting commands or data into a ground or satellite system.[3] The second threat is more worrisome. Many countries today have ballistic missile technology. More countries will acquire it in the future. To go from a ballistic missile to a vehicle capable of putting a payload to low orbit altitude is challenging but not overwhelming. If a country with little reliance on space and no concern for world opinion were to send up a nuclear weapon and detonate it as an anti-satellite weapon or even explode a warhead filled with shrapnel, the effects could be randomly disastrous. In the nuclear case, the electro-magnetic pulse would disrupt and very likely destroy the communications components of many satellites. In the latter case, shrapnel becomes space debris with the potential to severely damage any satellites with which it may collide. The randomness of the potential impact of such an event on all the satellites that could be affected may well be the biggest deterrent. With regard to this tactic, it's the less-than-rational actors and pariah states that feel they have nothing to lose by such a move that are most problematic. It also raises the difficult question of preemptive strikes as a matter of prevention; an issue without easy answers to be sure, but one a warfighting Commander-in-Chief (CINC) absolutely needs to consider as he plans.

Broadly, those are the basic concerns with ensuring unfettered U.S. access to its space advantage. But that's only half the space control equation. In comparison, the second part is

much more broadly scoped when one considers all the potentialities involved with denying an enemy the ability to take advantage of his own or other's space assets.

One common misconception deserves mention at the outset. The Outer Space Treaty is often thought to specifically prohibit weapons in space. What it actually prohibits is "weapons of mass destruction" in space.[4] Experts most assuredly argue that such a definition is quite ambiguous.[5] For purposes of discussion, this paper assumes only weapons of mass destruction, especially nuclear weapons, are explicitly prohibited. Current U.S. policy prohibits weapons in space, which may or may not change with the next administration or Congress, though theoretically it could.[6] The debate on whether or not it should change is outside the scope of this paper. However, the concept merits mention. For many years spacepower advocates argued for anti-satellite weapons (ASATs). Both the Soviet Union and the United States developed and tested ASATs in the 70s and early 80s. There were far fewer satellites then. A serious problem with using destructive ASATs is that they create space debris. Blowing up a satellite can create a few to myriad pieces, each of which remains in whatever orbit it falls into after the explosion. These many pieces each become a potential ASAT to anything whose orbit it crosses. The non-discriminating potential repercussions for friendly or neutral satellites can be quite significant. For example, during a tour of the space shuttle complex, the author saw the result from one of the space shuttles striking a chip of paint while in orbit. With the shuttle traveling at 17,000 miles an hour through space, the chip was apparently traveling across or opposite the shuttle's direction because it penetrated several layers of the extra-strength, cross-plied and laminated glass in the shuttle window. There are obvious severe downsides to explosively destructive ASATs. An ASAT that neutralizes a satellite without causing debris is an entirely different matter.

Air Force doctrine discusses various methods of disrupting an adversary's ability to exploit space. They include deception, denial, disruption, degradation, and destruction of space assets or capabilities by lethal or non-lethal means.[7] In theory, all three segments of space systems are vulnerable, and the means employed may be offensive or defensive.

The choices may seem easy and clear in some cases. Command and control nodes have long been key targets in wartime. If a node is part of a space system belonging to an enemy and is a legitimate target, it's an easy call. If a military ground processing station is taking satellite imagery and using it for targeting, it's a prime target. If an enemy satellite control station can be jammed by ground, sea or air forces so the satellite can no longer be controlled, it's a definite target. The list goes on when an enemy is like the United States and has many of its own space systems. The cold reality is that there are few countries and even fewer adversaries with anything close to America's space capabilities. Rather, space has become a huge source of commercial enterprise and international cooperation. This is one of the biggest changes since the Gulf War.

CURRENT SITUATION

In 1996, for the first time in the United States alone, commercial space launches outnumbered military launches and commercial space revenues exceeded government space expenditures.[8] Total worldwide investment in space is in excess of 500 billion dollars from more than 1100 commercial companies spread among 53 countries, with more than 1000 new satellites scheduled for service in the 1998-2008 timeframe.[9] U.S. national, and multinational corporations along with international consortia are all rapidly expanding their involvement in space. The data illustrate how space is becoming (or has become) a vital

interest much like oil for industrialized nations. Space control potentially becomes an issue much greater than just a military consideration.

For many countries it's far more practical to lease or buy space capabilities from commercial providers or other countries than to develop all the prerequisite infrastructure for an indigenous space program. This is not to imply the U.S. and coalition forces only used dedicated military space systems during Desert Shield and Desert Storm. In fact, they used a great deal of commercial capability, from the French SPOT satellite's multi-spectral imagery to leasing bandwidth from commercial satellite communication systems.[10] What has changed is the quantity, quality and diversity of commercial capabilities now available. For instance, SPOT's best imagery was 10-meter resolution during the Gulf War, meaning a pixel represented a 10 x 10 meter square.[11] Today there are 1-meter resolution systems available. This is not a 10-fold increase, but rather a 100-fold increase: 10-meter resolution has 100 one-meter squares; 1-meter resolution has one.[12] A sample of 5-meter resolution is shown in Figure 1 to compare it to the inherent clarity of the 1-meter resolution shown in Figure 2.[13]

Figure 1: Munich Germany (5m resolution) (Imagery by SpaceImaging)

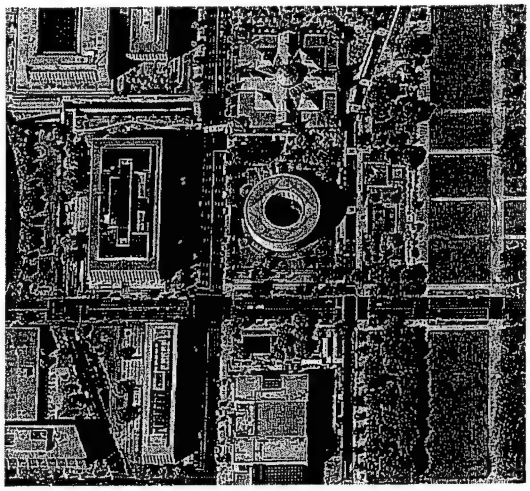

Figure 2: Hirshorn Museum on the Mall (1m resolution) (imagery by SpaceImaging)

Note the clarity and ease with which even cars can be seen in Figure 2. The 1m photo was

also reduced in size to fit in this paper, when expanded to full size the clarity is even more vivid. Additionally, because the data is digital for both it lends itself to a variety of applications, enhancements, and manipulations. The Munich image is actually a fusion of 20m multi-spectral and 5m panchromatic imagery from the Indian Remote Sensing satellite.[14]

The images shown in Figures 1 and 2 were downloaded from the web site of the American company, SpaceImaging. They were free samples of available imagery. The company offers its best imagery in panchromatic 1-meter resolution and 4-meter resolution for multi-spectral. Imagery is sold by the square kilometer (sq km) for less than $100/sq km of North America, prices for other continents were not posted. Minimum orders were $1000 for North America and $2000 for other areas respectively. Purchases could be made on-line with a credit card. For specific requirements an 800 number was provided.[15] The images shown demonstrate how the company can use their new IKONOS satellite, or meet user needs in many ways because they can incorporate data from "...the Indian Remote Sensing satellites, U.S. Landsat, Canada's Radarsat, the European Space Agency's ERS satellites and the Japanese JERS imaging system."[16] All this capability comes from one web site available worldwide.

This example illustrates not only the tremendous capability available but also shows how diverse the sources of data are globally. The non-U.S. agencies listed above distribute imagery through other avenues as well. A brief list of non-U.S. capabilities on the market follows: Canada's Radarsat - 8m radar images; India's Remote Sensing satellites – 5.8m imagery; Russian archived imagery – 2m; and France's SPOT – 10m multi-spectral

(projected to go to 5m by 2001).[17] In addition, two other U.S.-based companies, Orbimage, and EarthWatch, are scheduled to launch their own 1m resolution satellites this year.[18]

Because the imagery leaders are U.S.-based, planners might expect to have a greater degree of control over them in terms of what pictures they can take, commonly referred to as "shutter control." Unfortunately, the issue is far from clear. Negotiations are currently underway but the existing guidance is a 1994 Presidential Directive (PDD-23) that gives shutter control to the Commerce Department with the caveat they must consult the Departments of State and Defense.[19] Industry leaders are concerned that the limits may be too arbitrarily implemented. Orbimage's Vice President put it quite clearly,

> "If shutter control is implemented every other Thursday because there's a foreign policy concern off the coast of Slovenia, and a GS-15 calls and says you're shut down for three days, our foreign customers are going to run away from us and go to the French and others."[20]

There are several other developments that further emphasize the growing global scope of space activity. Italy is seeking partners to salvage their light launch development program; the Vega booster is targeted to come to market with an under $20 million cost.[21] A Russian and European consortium is developing a lightweight inflatable reentry system that would allow recovery of upper stages, experimental payloads and even satellites.[22] Such a system could potentially give satellite recovery capability to other nations when the United States currently enjoys a virtual monopoly with the space shuttle. These are but a few among many new developments indicative of the growing international reliance on and capability to exploit space.

IMPLICATIONS AND RAMIFICATIONS

Why the long discussion of improved capabilities? The proliferation of high quality capabilities in the international and commercial sectors severely complicates the space control issue. During the Gulf War, France was part of the coalition, and no other commercial enterprise was providing imagery to Iraq. The French government pressured SPOT (a commercial entity) to cut off Iraq's imagery supply. Since there was no competition to fill the void for Iraq, SPOT agreed, but had there been a competitor they likely would not have cooperated.[23] In fact, the coalition relied heavily on SPOT for multi-spectral imagery. Now, with many commercial providers, especially when the provider's country is not part of a U.S. coalition, the issue becomes quite complex. Suddenly, destroying, disrupting or denying the ground stations may have some broad consequences. As noted earlier, for U.S.-based firms like Spaceimaging, the Commerce Department retains a degree of "shutter control" on what can be photographed. Denying access to an area for national security concerns seems like an easy and reasonable call. But what happens to U.S.-based companies when they routinely deny customer requests because of national security concerns? First, if customers can go to a source with no U.S.-imposed restrictions for the data, there's little to be gained by shutter control. Similarly, if the data an enemy is getting doesn't provide real-time advantages the planner must consider whether or not an archived data base has already been established. For fixed locations like bases, barracks, factories, ports, or storage facilities, a semi-intelligent adversary could easily have accumulated targeting data along the way, which means cutting off a supply with no real-time value accomplishes very little. The Commerce Department will also recognize this (or be forcefully reminded) which, when coupled with their traditionally much more pro-business

approach in weighing security, may well result in a non-interference decision. Secondly, if a company gets arbitrarily shut off and loses customers, as the Orbimage official predicted, such a situation may have long term implications for the United States if companies lose incentives to push technology, or if other countries expand or enter and take over formerly U.S.-dominated markets. The possible outcomes are quite diverse, yet the point is that the issue becomes very complex quite quickly. Even though such considerations are not the direct purview of an operational planner, they are factors that affect planning and therefore must at least be acknowledged. This complication is even more significant if U.S. military reliance on commercial space assets continues to increase.

Other countries pose similar problems. Is there much doubt about how much France would lean on SPOT if France were not part of a U.S.-led coalition against some adversary who was buying SPOT imagery of areas where U.S. troops were marshalling or other operations were underway, especially if other vendors were in competition? China, India, and Russia all either have or are acquiring overhead imagery capabilities that they could sell or may share with an adversary. The complexities keep accumulating, yet to this point the discussion has focused primarily on imagery. Communications satellite capabilities are even more common and commercialized. In Bosnia and Kosovo, the broad coalition was able to exert some influence in getting certain links turned off to the adversary but the satellites were serving many European customers, including allies, so neutralizing those communications satellites entirely was never an option.[24]

Are there any options still open? This is where the CINC may well have to solicit help in exercising other instruments of national power, such as political or economic. Possibilities include political pressure on the offending country or the country where the

offending company is based. Another option may require buying all capability or paying a company to offset losses, although this may be an expensive option. Estimates of the worldwide market for remote sensing imagery range from one to five billion dollars by the 2004-05 timeframe.[25] The "buying all the supply" option also does not protect the U.S. firm worried about getting a reputation as an unreliable supplier. In the big picture, the shutter control option may be one that is used only reluctantly.

Similarly, space control in some circumstances may become nearly impossible. GPS is a prime example. Because it is so widely used and relied on, international pressure to keep it universally available is tremendous. Further, because of advances in computing power, commercial enterprises can get incredibly accurate data even if selective availability measures are used. U.S. reliance on GPS for everything from airliners, to trucks, to tanks, to cruise missiles, to new precision guided munitions means the likelihood of turning it off or degrading it, diminishes significantly. Another case, referred to earlier, is the adversary who stockpiles an imagery database of fixed sites, particularly to build targeting data for use in such things as his ballistic missiles.

What does this mean for the operational planner? It means the aspects of space control are multidimensional and may very well require the proverbial "thinking outside the box". The key to such thought is to ask the right questions or make the right considerations. It also means space control must be a primary consideration at the outset in the planning process, whether in deliberate planning or crisis action planning.

THE TASK OF PLANNING

In this author's experience the number of people well-versed in space operations is very limited. Though outside the scope of this paper, just the fact that in the U.S. military

space was historically in the scientist's realm of research and development, rather than the warfighter's realm, has left space with a non-operational bent. Fortunately, this is changing steadily as senior leadership of all services recognizes the significance of space operations. Still, space is not always at forefront when planners are building a commander's estimate or developing courses of action; yet space forces and capabilities will be vital to nearly every operation. From the friendly perspective, space assets must be fully exploited and protected, the latter of which is space control. Looking at enemy capabilities, and denying space access may provide significant advantages and drastically degrade the enemy's situational awareness and intelligence capabilities. This is also space control. There are several other aspects that should be addressed as well. Who will do that on the staff?

Currently the Air Force deploys theater support teams from the Air Force component of U.S. Space Command to various Joint Force Commander staffs and is trying to get more space-knowledgeable people permanently assigned to such staffs.[26] However, the reality for the near term is that there is a definite lack of space expertise routinely available. After nearly a year at the Naval War College in dealing with some extremely bright and talented officers and civilians from all branches of the services, the author found that the general lack of space awareness is due to lack of exposure more than anything. Curriculum-based discussion of space systems and contributions is cursory at best and not emphasized at all. Joint doctrine, which is covered in the Joint Military Operations curriculum, is of little help. Joint Publication 3-14, on Space Operations, is still in draft and appears to have been since at least 1995.[27] Air Force Doctrine on Space Operations is dated 23 August 1998, yet despite spending five of the last six years in active-duty operational Air Force space squadrons, the author's first encounter with written Air Force space doctrine was in research for this paper.

Consequently, it's really no surprise relatively few military operators have thought very much about space. Many operators are aware of some of the particular capabilities they use, such as GPS, satellite communications, satellite imagery, etc. However, most of these same people had no need to put very much thought into how that space capability really works or how an enemy might be denied the same capability. They simply took space capability for granted. Many air power advocates argue that U.S. forces and even the public take air superiority for granted as well. The fact that the last attack on U.S. forces by an aircraft was nearly 50 years ago in Korea helps explain why it's easy to take something the United States has dominated for so long, like air superiority or space exploitation, for granted.

Fortunately, the expertise that soldiers, sailors, airmen, and marines bring to the table in planning can be readily utilized to a large degree in considering space control. Several aspects are very similar to what each of the services work on in their own respective areas of concentration. Defending a ground site, protecting a communications link, jamming certain frequencies, attacking specific buildings or antenna sites, destroying a ground-based weapon such as a laser or missile launcher, or cutting off power to a vital facility are all tasks with which they are quite familiar. Other aspects, like using non-military methods to achieve certain objectives, are less familiar but not unknown. When perspectives were explained and constraints and second order effects considered, these non-space experienced officers were quite capable of developing creative solutions and extrapolating the possibilities and limitations. Such an admission may be heresy to the space purist or those defending space turf. But the intent of the discussion is not to usurp anyone. Instead, in view of the proliferation of space capabilities and increasing reliance on space, the purpose is to broaden

the awareness and tap the common experience base that can best develop the variety of solutions that may be necessary to achieve space control.

THE MODEL

The author's experience working with sister service personnel was the driving force in the development of a tool to help planners, especially those without space experience, better understand the necessity as well as the limitations of space control. To that end, the following model is presented. It is not an infallible fount of guidance with all the answers to issues on space control. Just the opposite, it asks questions to help identify the pertinent issues regarding space control so the planners can better focus their diverse talent and expertise. By raising issues in a more general light, the vast experience and expertise on a planning staff can be more aptly applied to those issues requiring resolution.

The model works somewhat like a flowchart. It starts with Block I, which then sends the reader to either block II or III depending on whether the issue is related to the fundamental task of protecting friendly capability or the other task of denying enemy capability. Within each of those respective blocks the reader will be directed to a final set in which all the questions should be considered. Again, this model is designed to stimulate thought and help raise the right issues, there are no answers included.

Space Control Planning Model

Block I start

Is the issue about protecting or defending friendly space capability? (Yes: go to block II) (No: continue.) Is the issue denying an enemy the use of space to gain an advantage? (Yes: go to block III) (No: exit; not a space control issue)

Block II: Defending friendly space capability [you'll be directed to a set of questions]

Is the threat against on-orbit assets?
(Yes: go to set II-A) (No: continue)

Is the threat against ground station assets?
(Yes: go to set II-B) (No: continue)

Is the threat against communications links?
(Yes: go to set II-C) (No: exit, re-examine the issue)

Question Set II-A: Threat against friendly on-orbit assets [consider all questions]

1) Is the threat in violation of any treaties or are diplomatic options available?
2) Does national policy allow attack?
3) If the threat is space-based, what space attack options exist?
4) If the threat is space-based, what options exist to negate on the ground, i.e. control source, comm links, etc.?
5) Are there defensive options, i.e. moving or shutting down the satellite, using a back-up or alternate?

Question Set II-B: Threat against friendly ground assets [consider all questions]

1) Is there a ready back-up available?
2) Can other assets be used as a work around or by improvising?
3) Can the threat be neutralized, by force or persuasion?

Question Set II-C: Threat against friendly comm links [consider all questions]

1) Are other comm links available?
2) Can increasing power or improving the antenna offset the threat?
3) Can the threat be located, and if so, neutralized?

Block III: Denial of enemy use of space capability [you'll be directed to a set of questions]

Is the capability to be denied a legitimate military target, i.e. an enemy possession?
(Yes: go to set III-A) (No: continue)

Is the capability to be denied a capability we (U.S. or coalition) also use, i.e. INMARSAT or GPS?
(Yes: go to set III-B) (No: continue)

Is the capability to be denied controlled or provided by a neutral third party or ally?
(Yes: go to set III-C) (No: continue)

Is the capability to be denied controlled by a U.S. firm?
(Yes: go to set III-D) (No: exit, re-examine the issue)

Question Set III-A: Capability is a military target [consider all questions]

1) What effect is desired, i.e. temporary, permanent, occasional?
2) Can it be shut down with non-lethal means, including non-military?
3) What lethal means are feasible?
4) What is allowed by the rules of engagement (ROE)? Is ROE change required?

Question Set III-B: Capability is one we also use [consider all questions]

1) Can the enemy be selectively locked out?
2) Can a false signal be sent to him or other means for neutralizing?
3) Can defensive measures or OPSEC type measures offset his exploitation?
4) Can we or ally live without the system to deny him access?

Question Set III-C: Capability provided by neutral third party or ally [consider all questions]

1) Is this capability providing vital current data or does enemy already have a data base of the pertinent information, i.e. targeting fixed sites?
2) Can political pressure shut down his access?
3) Can the supplier(s) be bought or bartered out of providing to the enemy?
4) Is force a realistic option, i.e. especially non-lethal such as jamming?

Question Set III-D: Capability is controlled by a U.S. firm [consider all questions]

1)	Does a U.S. government office exercise any control?
2)	Is another less controllable provider available to the enemy?
3)	What are the consequences of shutting down the provider, i.e. financial long and short term, precedent setting for other U.S. businesses and our own use compared to true advantages?
4)	Can a deception operation be run, i.e. control the data being sold?

CONCLUSION

Since the Gulf War, space activity, reliance on space, and space capabilities have increased dramatically. The increases have been by nations, commercial businesses and multinational consortia. The proliferation of capability means any adversary the United States may next face will most likely be using space in several ways. An adversary contemplating engaging the United States will also realize how reliant on space the U.S. military is. Accordingly, it's reasonable to assume they will use every means at their disposal to disrupt U.S space dominance. Therefore, space control must be at the forefront in any operational planning.

The incredible advance in commercial and foreign satellite imagery, such as resolutions of one meter available on the internet to anyone with a credit card, raises complex issues for operational planners deliberating space control. Because there a limited number of space experts and because many aspects of space control are common with operations in the other mediums, it makes good sense to take advantage of the skills operators from all

services bring to the table. Solutions employed will have to be creative and will most likely employ a combination of lethal, non-lethal, and non-military means.

The model presented in this paper can help the planners with limited space experience identify the diverse issues associated with space control. It could be used at a joint task force or CINC's staff, or could be employed in simulations, training, wargames or even professional military education. The model provides no answers but helps planners consider means, both non-military and military, to achieve space control from the start. Only by doing so can the United States take advantage of its tremendous space capabilities and deny to the maximum extent possible any advantage an adversary could gain from space assets.

Notes

[1] Frank Gallegos, After the Gulf War: Balancing Spacepower's Development (Maxwell AFB, AL: Air University, 1996), 3.

[2] U.S. Space Command, Long Range Plan, Implementing USSPACECOM Vision for 2020, (Peterson AFB, CO, 1998), 19.

[3] Cynthia A. S. McKinley, When the Enemy Has Our Eyes, (Maxwell AFB, AL: Air University, 1995), 42.

[4] Alasdair McLean, Western European Military Space Policy, (England: Dartmouth Publishing Company Limited, 1992), 170.

[5] Jim Oberg, Space Power Theory, (U.S. Air Force Academy, CO: Government Printing Office, 1999), 82

[6] Ibid., 129.

[7] HQ U.S. Air Force, Space Operations (Air Force Doctrine Document 2-2) (Washington: 23 August 1998), 8.

[8] U.S. Space Command, 3.

[9] Ibid.,5

[10] McKinley, 36.

[11] Ibid., 33

[12] Ben Iannotta, "Setting the Rules For Remote Sensing," Aerospace America, April 1999, 36.

[13] SpaceImaging Web Site, "First Images," Imagery of Ronald Reagan Washington National Airport and Hirshorn Museum and Sculpture Garden, 30 September 1999, <http://www.spaceimaging.com/ikonos/firstimage.htm> (12 May 2000).

[14] SpaceImaging WebSite, "Gallery," Munich, Germany, 9 August, 1999, <http://www.spaceimaging.com/gallery/ioweek/archive/iow80999/iow809.htm> (15 May 2000).

[15] SpaceImaging Web Site, "Products."

[16] Ibid.

[17] Joseph C. Anselmo, "Shutter Controls: How Far Will Uncle Sam Go?" Aviation Week & Space Technology, 31 January 2000, 56.

[18] Joseph C. Anselmo, "Competitors Chasing Ikonos Into Orbit," Aviation Week & Space Technology, 31 January 2000, 57.

[19] Anselmo, "Shutter Controls: How Far Will Uncle Sam Go?" 55.

[20] Iannota, 35.

[21] Michael A. Taverna, "Last Chance for Vega." Aviation Week & Space Technology, 31 January 2000, 42.

[22] Michael A. Taverna, "Soyuz to Test Revolutionary Inflatable Reentry System." Aviation Week & Space Technology, 31 January 2000, 41.

[23] Mckinley, 22.

[24] Don Blackwelder,. Lt Col, USAF, USAFE Planner during Kosovo Campaign. Conversation with author, 24 February 2000.

[25] Michael Mecham, "Finally, Debut Nears for 1-Meter Satellites," Aviation Week & Space Technology, 5 April 1999, Academic Universe/Document, Lexis-Nexis, (28 April 00), 2.

[26] HQ US Air Force, 5-6.

[27] "Joint Pub 3-14 Publication Status," Lkd. "Joint Doctrine Web Site," <www.dtic.mil/doctrine/pubstat/stat314.htm/> (30 April 2000).

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